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Herbigation Workshop Proceedings

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Rural Development Center
Tifton, Georgia
July 9-10, 1991

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Herbigation Workshop Summary

Herbigation research is now being conducted in Prosser, Washington; Lubbock, Texas; Stoneville, Mississippi; and Tifton, Georgia. Most of this research is now being conducted by five ARS and two University scientists. It is estimated that currently the support for Herbigation research is less than $600,000 annually.

Herbigation has been successful with many soil-applied herbicides. The results of applying postemergence herbicides by Herbigation have been promising but erratic. Continued research is needed in areas such as modifying application volume and developing new formulations to expand this technology in postemergence applications. Then, Herbigation can be integrated into many irrigated production systems.

This application technology can potentially reduce herbicide rates, reduce applicator costs, reduce application exposure, and reduce nonpoint source pollution. The basic principles in Herbigation application technology can be integrated into the application of other agrichemicals such as fertilizers, insecticides, fungicides, and nematicides. This interdisciplinary approach would have a significant impact on reducing environmental impact and application costs. This research should be continued at the present locations and expanded to other irrigated areas of the Central United States. This could mean as much as 5 SY's devoted to irrigation application technology with emphasis on Herbigation.

The term "Herbigation" is a registered trademark of ICI Americas, Inc.

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Herbigation Workshop Agenda

July 9-10, 1991
Rural Development Center
Rooms 2 and 3
Tifton, Georgia 31793

TUESDAY - JULY 9, 1991

8:00-8:30 a.m.	Register Coffee/donuts	Lobby of RDC
8:30-8:40 a.m.	Welcome and Review of Program	Dowler
8:40-8:50 a.m.	Purpose of Meeting	Antognini

Past and Present Status of Herbigation Research and Commercial Use

8:50-9:00 a.m.	West	Boydston
9:00-9:10 a.m.	Central (North)	Schweizer
9:10-9:20 a.m.	Central (South)	Lyle
9:20-9:30 a.m.	Delta	Hanks
9:30-9:40 a.m.	East (Horticulture)	Glaze
9:40-9:50 a.m.	East (Agronomy)	Dowler
9:50-10:05 a.m.	Discussion	
10:05-10:20 a.m.	Coffee Break	
10:20-10:35 a.m.	EPA Guidelines for Registration of Herbigation Use Patterns	Odiott

Engineering Aspects of Herbigation Equipment

10:35-10:50 a.m.	Development of Safety Equipment	Threadgill
10:50-11:05 a.m.	Development of LEPA	Lyle
11:05-11:20 a.m.	Influence of Systems on Droplet Size Formation and Distribution	Sumner
11:20-11:35 a.m.	Questions and Answers/Discussion	

Industry Approach to Herbigation

11:35-11:50 a.m.		Agri-Inject
11:50-12:05 p.m.		ICI
12:05-12:20 p.m.	Questions and Answers/Discussion	
12:30-1:30 p.m.	Lunch	
1:30-5:00 p.m.	Visit, Review, and Evaluate Facilities, Equipment, and Herbigation Research in Progress at ABAC Farm, Rural Development Center, Bowen Farm.	

WEDNESDAY, JULY 10, 1991

Future of Herbigation

8:00-8:15 a.m.	West	Boydston
8:15-8:30 a.m.	Central (North)	Schweizer
8:30-8:45 a.m.	Central (South)	Lyle
8:45-9:00 a.m.	Delta	Hanks
9:00-9:15 a.m.	East	Glaze
9:15-9:30 a.m.	East	Dowler
9:30-9:45 a.m.	Questions and Answers/Discussion	
9:45-10:00 a.m.	Break	
10:00-10:45 a.m.	Two Breakout Groups, Review Herbigation Progress, and Formulate Future Objectives and Approaches	
10:45-11:15 a.m.	Consolidate Suggestions of Breakout Groups and Summarize Activities Involved in Workshop	
11:15-11:30 a.m.	Final Remarks	
11:30 a.m.	Adjourn	

Herbigation Workshop Introductory Comments

Clyde C. Dowler

I welcome all of you to Tifton, the Coastal Plain Experiment Station, and the Herbigation Workshop. The agenda developed is structured and, as you can see, there are certain time restraints on presentations, discussions, and summary. We will adhere to the agenda as closely as possible, but we will allow sufficient time for questions, answers, discussions, and one-on-one comments.

Dr. Joe Antognini suggested the idea of holding a Herbigation Workshop in the Fall of 1990. The involvement of the USDA-ARS personnel in Herbigation and other chemigation research and the facilities available made Tifton the logical location to hold this Workshop. In February, 1991, an outline of the proposed Workshop was developed and, from that, we proceeded to develop the Workshop as outlined in the agenda.

We will review the past, present, and future of Herbigation research as dictated by the interest and production practices in five areas of the country. The areas are the Pacific Northwest, North Central U. S., South Central U. S., Mississippi Delta, and the Southeast.

We will review the past and present status of Herbigation, EPA Guidelines, and engineering aspects this morning. After lunch, we will tour the chemigation and groundwater research facility on the Abraham Baldwin Agricultural College Farm; followed by brief visits to a LISA project in conjunction with the Coastal Plain Experiment Station; Rural Development Center center pivot where Herbigation and conservation tillage research in cotton, triticale, and soybean are being conducted; and the Bowen Farm which utilizes six one-tower center pivots for Herbigation and other chemigation research. We will provide transportation to lunch and the field tour.

Tomorrow, we will reconvene at 8:00 A. M. to discuss the future of Herbigation research and have two breakout groups review Herbigation progress, formulate future plans, and summarize items discussed during the workshop.

We look forward to having a productive interchange of information in this Workshop. With that, I'd like to introduce Dr. Joe Antognini, National Program Staff - Weed Science, who will discuss the purpose of this Workshop.

The term "Herbigation" is a registered trademark of ICI Americas, Inc.

Herbigation Workshop Introductory Remarks

Joe Antognini

First, let me welcome you to this workshop and thank you all for taking your time to attend. I would like to add a special thanks to those of you who have traveled considerable distances.

By coincidence this workshop is being held during the month of the 30th anniversary of Herbigation. To my knowledge the first experimental and commercial uses of Herbigation were in California in July, 1961. The herbicide was EPTAM [R 1] and the first use was in flood irrigation of alfalfa and in permanent set sprinklers in potatoes. By the mid 1960's, there was extensive use of Herbigation with sprinkler, flood, and furrow irrigation practices in rice, alfalfa, green and dry beans, potatoes, sugar beets and tomatoes. The rapid acceptance of Herbigation was due to the fact that except for rice there were no herbicides available that would control weeds once they had emerged and preemergence herbicides were ineffective or difficult to apply in an established crop.

Although many of the principles of Herbigation apply also to chemigation, our discussions here should be restricted to Herbigation. The application of herbicides in sprinkler irrigation have some unique characteristics which are not applicable to the other materials applied in irrigation water. Also, we want to address Herbigation from a national standpoint and not just from a Southeastern or Southwestern standpoint.

The purpose of this meeting is to look at agricultural practices and environmental concerns of today and determine where and how Herbigation will fit in today's and tomorrow's agriculture. The end result of this workshop should be a consensus of where Herbigation fits, what research is needed and what constraints are there on the development of the practice and subsequent acceptance by the growers.

We must keep in mind that there is a shift away from preplant and preemergence herbicides to postemergence herbicides for three reasons. First, is a desire to treat the problem rather than an anticipated problem. Second, is the need/desire to not use herbicides which have a soil residual and potential to contaminate ground and surface water. Third, is the need for many growers to go to no-till in order to be in compliance with soil erosion laws which means leaving crop residue on the soil surface which reduces the effectiveness of soil-applied materials and eliminate the use of preplant-incorporated herbicides.

Herbigation Research and Use in the West

Rick Boydston
USDA-ARS
Prosser, Washington

Herbicide application through irrigation systems began in the early 1960's with the application of EPTC through solid set sprinklers by Stauffer researchers in California. Stauffer called the technique "Herbigation", and it was soon registered and marketed. Today, approximately 20 herbicides are registered in the State of Washington for application through irrigation systems. Currently, most herbicides used in irrigation systems are "soil active" type herbicides applied mainly through center pivot sprinkler systems. The most commonly Herbigated crops in Washington State are potatoes and field corn with approximately 120,000 acres total of each grown in the state.

Gravity or flood irrigation systems have inherent problems of water uniformity and runoff, but have been used successfully to apply EPTC and napropamide. Drip irrigation systems have been used to apply herbicides with limited success. Currently, only norflurazon is labeled for use in micro irrigation systems and only on citrus crops. Application of preemergence herbicides through drip irrigation systems has been tested with napropamide, oxyfluorfen, oxadiazon, oryzalin, simazine, norflurazon, and prodiamine. Problems with applying herbicides through drip systems are: 1) precipitates forming in the irrigation line and clogging emitters; 2) poor uniformity of the herbicide in the wetted area under emitters; 3) phytotoxicity to the crop; 4) accelerated degradation of the herbicide in the wet zone; and 5) proper timing of herbicide injection during the irrigation set.

Most Herbigation is done with sprinkler irrigation systems where water uniformity is better than with drip and flood irrigation. Dr. Alex Ogg (USDA-ARS) conducted numerous Herbigation studies in the 1970's gaining information on which many of our current labels are based. Dr. Ogg's research focused on the amount of water, herbicide characteristics, amount of herbicide, volatility losses, and other application parameters.

Today most of the research in the West is focused on herbicide leaching in the soil when applied through irrigation systems. Areas which need additional study are: 1) how soil texture and O.M. interact with amount of water and herbicide applied; 2) drift, volatility, and leaching losses of herbicides under various conditions and irrigation systems; 3) use of foliar active herbicides and adjuvants; 4) herbicide residues in crops that are Herbigated; 5) effect of soil moisture at the time of Herbigation on herbicide movement and efficacy; 6) use of multiple low dose applications to reduce total herbicide input; and 7) efficacy of herbicides applied through low pressure systems with rotary nozzles and LEPA systems.

The future of Herbigation hinges largely on environmental concerns and whether drift, volatility, and leaching losses can be minimized. Multiple applications of low doses that could reduce overall herbicide inputs and reduce herbicide residues in the crop could be advantageous. Industry will likely expand labels to include application through drip systems as more land is converted to drip irrigation.

Herbigation Labels in Washington and California

atrazine* (canceled)
alachlor
bromoxynil
butylate
chlorpropham (canceled)
DCPA
diethatyl ethyl
EPTC
MCPA*
metolachlor
metribuzin
napropamide
norflurazon* (drip only)
oryzalin* (CA only)
oxyfluorfen* (CA only)
pendimethalin
pebulate
propham
simazine
tridiphane* (canceled)
trifluralin
vernolate (canceled)

Past and Present Status of Herbigation Research and Commercial Use (North Central Region)

Edward E. Schweizer
USDA-ARS
Ft. Collins, CO

Scientists were interviewed in six states -- Colorado, Kansas, Nebraska, North Dakota, South Dakota, and Wyoming. These six states had over 7.2 million acres of land irrigated with sprinklers; this acreage represented 29% of the total acreage irrigated with sprinklers in the U.S. in 1990. Over 90% of the irrigated acreage in these six states was irrigated by center pivots.

Herbigation Research: Within the past 5 years, very little Herbigation research has been conducted in the Central Great Plains and North Central States. Based on a recent telephone survey, no Herbigation research is being conducted in Colorado, Kansas, Nebraska, South Dakota, North Dakota, and Wyoming. Interviews were conducted with seven weed scientists and five agricultural engineers/ agronomists.

Herbigation Use Patterns: Less than 5% of the acreage is treated with herbicides via sprinklers. Soil-applied herbicides are applied mostly through center pivots. These herbicides include alachlor, EPTC, metolachlor, and trifluralin. Very few postemergence herbicides are applied through sprinklers. Bromoxynil, a contact herbicide, is used, but weed scientists do not understand how it controls weeds when applied via sprinklers. Corn, potatoes, and wheat are the principal crops treated via Herbigation.

Potential Future for Herbigation: All of the weed scientists contacted felt that the future of Herbigation was limited. No weed scientist expressed any interest in conducting Herbigation research in their state. The principal reason being they were concerned of possible groundwater contamination. Other reasons stated by researchers were: off-target movement, safety, herbicide performance, lack of facilities and support to conduct the research, more important weed problems needed to be addressed in their states, the time it takes to treat fields, conflicts with other spring-time activities on the farm, mechanical problems often encountered during the start-up of sprinklers and increased restrictions and regulations by each state.

Several persons felt that the concept of Herbigation was high and if concerns over such issues as environmental, funding, and application technology could be addressed, the future for Herbigation would be brighter. Low pressure irrigation systems and low energy precision application (LEPA) may address some of the possible problems with Herbigation that is encountered today.

Summary of Chemigation Research for Crop Production in the Mississippi Delta

R. A. Wesley, J. E. Hanks, and M. A. Locke
USDA-ARS
Stoneville, MS

In 1976, two center-point irrigation systems (225' length) were installed near Stoneville, Mississippi, to conduct chemigation research on cotton, soybean, and small grains. Cotton research was conducted on a Dundee silty clay loam, whereas soybean research was conducted on a Tunica clay. Research involved the application of: 1) fertilizers and herbicides for wheat production in wheat-soybean doublecrop systems; 2) pre- and postemergence herbicides for monocrop soybeans and doublecrop soybeans planted no-till in wheat stubble and in a burned stubble environment; and 3) growth regulators and harvest-aid chemicals to cotton.

Results obtained are as follows:

Wheat: Thifensulfuron herbicide applied postemergence in a paraffinic oil carrier (Sun Ag Oil 7N) with 2% v/v oil emulsifier (Rohm & Haas X-363M) virtually eliminated all buttercup and seedling dock.

Soybean: Metolachlor plus metribuzin applied preemergence to monocrop soybean provided excellent control of a broad spectrum of broadleaf and grass weeds. Dual plus Sencor also provided excellent broadleaf and grass control in doublecrop soybean planted no-till in burned wheat stubble, and good weed and grass control in soybean planted no-till in standing wheat stubble. Lactofen applied postemergence with a paraffinic oil gave good results.

Research is presently underway to compare conventional ground application to chemigation by determining: 1) the efficacy of selected pre- and postemergence herbicides in soybeans; and 2) vertical movement of the herbicides in the soil. In 1992, research will be initiated to develop conservation tillage systems for cotton production with fertilizers, herbicides, insecticides, and defoliants applied by chemigation.

Summary of Herbigation Research Horticultural Crops

Norman C. Glaze
USDA-ARS
Tifton, GA

Herbigation research was initiated on horticultural crops at Tifton in 1978. The initial work was done with individual sprinklers on opposite corners of 12.2 X 12.2 m plots with injection via a venturi into each sprinkler. Successful weed control was obtained with soil-applied materials evaluated when compared to conventional applications. Research was then expanded under single tower center pivots on numerous vegetable crops grown in multiple-cropping sequences with agronomic crops. In most instances, the performance of soil-applied herbicides has been equal to or superior to conventional applications in the same tests. Isolated cases have been observed where high water solubility has caused the herbicide to leach beyond the level of weed germination which reduced weed control or resulted in poor crop germination and reduced stand. Variable results have been observed with postemergence herbicides which can be attributed to the high water application volumes. Applications to container-grown ornamentals have been simulated with a cage constructed of fiberglass and set over the containers through which herbicides were applied and has given favorable results with compounds such as alachlor or pendimethalin. Retreatment at 60-day intervals is necessary in ornamentals due to the high water requirements of a container-grown crop. It has been observed that weed control improves as the number of applications increase due to the residual chemical from previous treatments. More injury than acceptable has been observed on ornamentals with some herbicides which have postemergence activity when applied via Herbigation on ornamentals.

The future of Herbigation in the Southeast will probably increase as vegetable production is increasing at 4-5% per year in Georgia and is heavily dependent on available irrigation. With center pivot irrigation expanding, growers will want to make more efficient utilization of their equipment and capital outlay.

Past and Present Status of Herbigation Research and Use in Agronomic Crops of the Eastern U. S.

Clyde C. Dowler
USDA-ARS
Tifton, GA

Some exploratory and demonstrations of herbicide applications through irrigation were conducted in Georgia and other sites in Eastern U. S. in the late 1970's. Increased emphasis on Herbigation research began in 1980, partially as a result of a grant to the Coastal Plain Experiment Station in Tifton from the Richard K. Mellon Foundation for two million dollars over a period of about six years. The grant was directed to irrigation research in sandy soils of the Coastal Plain. However, it quickly became evident that irrigation technology could be used for more things than just applying water. In 1980 and 1981, considerable effort was directed to the application of soil-applied herbicides to corn, peanuts, and soybeans at numerous on-farm sites around Southwest Georgia as well as at research facilities of the Coastal Plain Experiment Station. This research demonstrated the effectiveness and versatility of utilizing irrigation as a method for applying several herbicides to the above crops.

New herbicide chemistry and use patterns evolved during the early and mid 1980's. These were incorporated into irrigation application research. This also included an increased emphasis on the evaluation of postemergence herbicides.

Almost without exception, results of soil-applied herbicides applied through irrigation resulted in weed control levels equal to or in excess of that expected by conventional application. Often crop tolerance also was improved with some herbicides.

Research on the application of postemergence herbicides produced variable but encouraging results. Generally, efficacy was increased when postemergence herbicides were mixed in a nonemulsified mineral or vegetable oil before injection into the irrigation system.

Presently, the efficacy of more than 25 soil-applied and 20 postemergence herbicides has been evaluated by irrigation application techniques in corn, cotton, peanuts, soybeans, alfalfa, and pearl millet. Present registration is limited to selected herbicides in corn, peanuts, and soybeans.

Presently, more than 700,000 acres of cropland are under center pivot irrigation in Georgia, but the use of Herbigation is limited to a very small percentage of that acreage. Effectiveness, economics, and use of co-chemigation (the simultaneous application of more than one agrichemical such as a herbicide and nitrogen) will influence the future of Herbigation in the Southeast U. S.

EPA PR Notice 87-1 on Label Improvement Program and Additional Policy Statement for Chemigation

Olga Odiott
EPA
Washington, DC

Copies of PR-87-1 on Label Improvement Program for Pesticides Applied through Irrigation Systems (Chemigation) and Interim Final FIFRA compliance Program Policy 12.7 related to PR Notice 87-1 were distributed to Workshop participants. These documents are in effect and included as an Appendix to this report. The Office of Pesticide Programs (OPP) is currently reviewing chemigation issues and requesting inputs from all interested agencies and personnel. The OPP is active at the present time and would like inputs within 30 to 60 days so that proper and precise decisions on upgrading guidelines for chemigation can be made. However, the present documents will remain in effect until decisions have been completed and implemented.

The Development of Herbigation Safety Equipment

E. Dale Threadgill
Biological & Agricultural Engineering
University of Georgia
Athens, GA

Herbigation safety equipment has been developed to prevent the occurrence of the three following hazards: (1) backflow or siphonage of dilute or concentrated herbicide into the water supply, (2) backflow of irrigation water through the chemical injection system, and (3) excessive concentrations of chemicals in the irrigation systems. Both a backflow prevention system on the irrigation mainline and a chemical injection safety system are required to effectively protect against the three listed hazards. The U. S. EPA has established minimum safety equipment requirements for herbigation. Many states have developed laws and regulations stipulating safety equipment requirements for herbigation. The American Society of Agricultural Engineers (ASAE) has developed an Engineering Practice describing appropriate herbigation safety equipment and systems. These regulations and the engineering practice describe a range of components along with suggested component arrangement and maintenance guidelines. Safety components include check valves, low pressure drains, normally closed valves, flow or pressure switches, vacuum relief valves, and power interlocking systems. These components are readily available from a variety of manufacturers. The cost of herbigation safety systems depends upon the degree of protection desired or required. A University of Nebraska evaluation of the reliability of selected safety system components indicates that the degree of protection is acceptable. The use of appropriate herbigation safety equipment coupled with good maintenance and management practices will provide very reliable protection for the operator and the environment.

Past and Present Status of Herbigation Research and Commercial Use (South Central Area)

W. M. Lyle
Texas A & M University
Lubbock, TX

Herbigation use and research have been primarily confined to Texas in the South Central area and to the Texas High Plains in particular. However, this area alone represents 4.6 million irrigated areas. Pivot irrigation makes up about 33% of the total or about 1.5 million acres and is expanding rapidly. It is estimated that 30 to 50 percent of pivot owners/operators use Herbigation and/or chemigation of some type.

Herbigation research has been focused on nozzle packages and delivery systems which will allow highly targeted application of all chemicals applied through a pivot. It has been based around application from LEPA type nozzles which are located near the soil surface. Combinations and rates of preemergence and overlay herbicides have been evaluated in both conventional tillage and conservation tillage situations and compared to conventional ground application. Herbigation has been found to be as effective as conventional ground methods.

LEPA systems are now under design which will offer continuous uniform movement and will be capable of high speed operation. Along with this, auxiliary chemical application nozzle systems are being developed which can cut the water application rate to 1/4 that of irrigation. This combination can lower the water application volume to 1/30 of that currently used for chemigation/Herbigation. This should greatly enhance foliar herbicide efficacy as well as activity of most insecticides and reduce the need for oil in many applications.

Herbigation and chemigation research is vitally needed to meet future needs. It has been estimated that the Texas High Plains, by necessity, will in the near future be irrigated primarily by LEPA/pivot systems. With an adequate research and extension effort, this entire area could reap tremendous benefits from multifunction use of these systems through chemigation/Herbigation applications.

Influence of Systems on Droplet Size Formation and Distribution

H. R. Sumner
USDA-ARS
Tifton, GA

Oil-formulated herbicides applied to crop foliage by irrigation are generally more efficient than water formulations for controlling weeds. The size of droplets delivered to the plant influences the amount and distribution of herbicide retained on the plant foliage and the resulting weed control. Small droplets usually provide better weed control than large droplets. Mainline water velocity, injection port orientation, and sprinkler nozzle influence droplet size distribution of oil-formulated, nonemulsified pesticides in chemigation systems. As the mainline water velocity is increased, volume median diameter and the percentage of oil contained in large droplets decrease, and the percentage of oil volume in small diameter droplets in the mainline increases. Droplets emitted from sprinklers have smaller volume median diameters and are influenced less by injection methods than droplets in the system mainline. The sprinkler nozzle can significantly reduce or eliminate the effect of mainline parameters on oil-pesticide droplet distributions delivered to plant foliage.

Oil-formulated droplet distributions generated by injection into irrigation mainlines are important in transporting pesticide to attain uniform distribution at sprinklers along the pivot line. Large droplets may float out of the water in the pivot line and be removed at sprinklers near the irrigation pivot point. Early removal of droplets can greatly reduce the distribution uniformity of pesticides along the pivot line. Oil droplet distributions in pivot lines should be <500 microns to prevent "float out", but droplets <100 microns provide better distribution. Mainline water velocities <1.5 m/s at the injection point may generate droplet distributions that contain an excessive number of large droplets, resulting in poor uniformity of droplet transport along the pivot line.

The size distribution of oil-formulated herbicides in the mainline and from sprinklers affects the biological activity of herbicides applied postemergence through irrigation. Therefore, the design of irrigation systems is important to the success of Herbigation in production agriculture.

Industry's Thoughts and Approach to Herbigation at the Present Time and Outlook on the Future

James N. Lunsford
ICI Americas, Inc.
Dothan, AL

ICI Americas, Inc., presently has registered for application by irrigation the following products: Eptam, Eradicane, Eradicane Extra, Sutan +, Vapam, Devrinol, Ambush, and Cymbush. The outlook for these products by ICI Americas or other products from industry to be applied by irrigation in the future will revolve around four specific areas in my opinion.

1. Sales Volume: Will the volume of sales produce a return on investment (profit) to justify a registration use pattern for that products sales volume.

2. EPA Requirements for Registration or Reregistration: EPA considers the use of an irrigation system to apply pesticides as another application method such as an aerial application, or with fertilizer either liquid or dry bulk. Specific protocol requirements for reregistration set up by EPA for application with an irrigation system could be limiting due to the very high cost of conducting such protocols. Also, the type of trials may be very expensive to conduct, such as leaching, runoff, mesocossom, groundwater, loader/mixer exposure, drift, atmospheric loss, and others.

3. Registrations for Minor Uses: Due to the high costs of re-registration and the limited sales volume of these products, new minor use registrations in the future will be limited or many will be canceled.

4. Governmental Controls by Federal and State Laws: Water usage, contamination, and quality will become very political or environmental topics in the future, and future laws or regulations may be very restrictive in the usage of irrigation and/or the application of pesticides by irrigation. These could greatly limit the future registrations of new products from the pesticide industry.

While these topics seem to present a somewhat negative outlook on Herbigation in the future, there are some very positive aspects. Consistent or improved performance efficacy for products applied through irrigation. Possibility of marketing niches for specific products based on regional crops or returns to growers who use products applied in irrigation systems. Unlimited research opportunities with new products, formulations, irrigation application technology, application equipment, lower rates, and others. I do feel that registrations of new products applied by irrigation will have to proceed on a regional basis due to the interest of research personnel, irrigation equipment, grower interest, and need for such a use pattern.

ICI Americas, Inc., has stated the position that it will reregister all product use pattern registrations presently approved. Therefore, all ICI herbicides registered for use through irrigation will be reregistered to maintain that particular use pattern.

Industry Approach to Herbigation

Gary Newton
Agri-Inject, Inc.
Yuma, CO

The purpose of my presentation is to show the importance of informing law makers, regulators, and users of all the research, equipment, development, and relative safety of Herbigation and chemigation.

Research from trials has been compiled from colleges, chemical companies, and farmers, including my own personal use, for the past 20 years. The equipment was developed for the purpose of more precise, accurate, and reliable application procedures of herbicides. By having fail safe, reliable equipment, Herbigation and chemigation are far more desirable.

My presentation and discussion will include the incorporation advantages and efficacy of chemicals applied by Herbigation, timeliness and activation of herbicides applied by Herbigation, the potential for containment of chemicals within a well column if an accident would occur, the possibilities of cleanup of aquifers after contamination, and comparison of off-target application techniques.

I also will discuss the current commercial equipment available with particular reference to check valves, backflow devices, calibration columns, mixers, agitators, tanks, and injection metering pumps.
The Institute of Agriculture and Natural Resources at the University of Nebraska-Lincoln released the final report of the Burlington Northern Foundation Water Quality Project on August 1 of last year. The five-year study covered the use of chemigation and its effects on quality of essential groundwater resources.

The conclusions of the study were that when proper procedures are followed, chemigation is an effective method of applying chemicals and the risk for leaching into the groundwater appears no greater than other conventional methods of application.

Colorado State University also investigated chemigation. They released their study in September of 1986. The study, "Potential Groundwater Impacts from Chemigation" was written by James W. Warner and Kit Nielsen. Their findings show that even if the backflow devise should fail, it is possible to clean the spillage and return the amount of contaminates to acceptable levels.

Summary of Field Tour

Clyde C. Dowler
USDA-ARS
Tifton, GA

The Abraham Baldwin Agricultural College (ABAC) chemigation and groundwater research facility was viewed immediately after lunch. Initial stops were made on small plots of cotton treated with the irrigation system simulator with Poast and Fusilade demonstrating the postemergence activity of both herbicides on Texas panicum and crabgrass. The irrigation system simulator was also demonstrated in operation.

The crop rotation and general research objectives of the center pivots at the ABAC facility were discussed. The irrigation and sprinkler systems were discussed and demonstrated. In addition, a detailed presentation was made on the sampling techniques for monitoring selected agrichemicals in the soil profile through the crop root zone. Weed control on cotton and peanuts was observed in the conservation tillage under the center pivot.

The next stop was on the LISA Project on the Animal Science Farm demonstrating automated equipment for applying animal waste material through irrigation and a discussion and review of the instrumentation and data collection systems.

The third stop was the RDC center pivot where a brief history of the center pivot was given and some research objectives on conservation tillage being conducted at the present time. The RDC center pivot is more than 20 years old and has had intensive use for that period of time. Although the unit control box and sprinkler packages were replaced in 1990, the basic center pivot hardware is still in good condition even after 20+ years of applying agrichemicals. Research under that center pivot involves a cotton-triticale-soybean rotation grown with conservation tillage and utilizing the center pivot for application of all production materials. Basic research interest involves production as well as the influence of tillage practices on weed ecology.

The fourth stop was at the Bowen Farm where the history and research objectives of six single-tower center pivot systems were presented. This facility is located on flatwoods soil common to all of Southeastern Georgia (more than 11 million acres) and represents a major soil type for tobacco production. This facility was initially dedicated to

multiple-cropping around tobacco. But, research emphasis recently has shifted somewhat away from tobacco research. Two pivots at the Bowen Farm are now dedicated to duplication of rotations being studied at the ABAC Research Facility with a one-year time lag.

The entire field tour was designed to show research facilities available at the Tifton location, general research objectives, and at least some preliminary results. Researchers at Tifton have available 14 single-tower center pivot systems and two three-tower center pivot systems which various aspects of Herbigation and other chemigation research can be conducted. In addition, there are two irrigation system simulators available on which screening of herbicides and other agrichemicals as well as water volumes and nozzle packages can be researched in relatively small plots.

American Society of Agricultural Engineers (ASAE) Chemigation Safety Committee

E. Dale Threadgill
Biological and Agricultural Engineering
University of Georgia
Athens, GA

The Irrigation Management Committee is one of many technical committees of the American Society of Agricultural Engineers (ASAE). In the late 1970's, the Irrigation Management Committee appointed a subcommittee to develop an ASAE engineering practice related to chemigation safety devices. The subcommittee's membership is comprised of individuals from universities, public agencies (research and regulatory), and industry. As a result of this subcommittee's activities, ASAE Engineering Practice EP409 entitled "Safety Devices for Chemigation" was approved by ASAE in January, 1982, after rigorous review through the ASAE technical committee structure. ASAE's guidelines for Engineering Practices require that each Engineering Practice be reviewed at approximately 5-year intervals, such review requiring reballoting for approval through the ASAE technical committee structure. ASAE EP409 was reconfirmed in December, 1986. ASAE EP409 was significantly revised and approved in May, 1989, as ASAE EP409.1 Safety Devices for Chemigation. This engineering practice includes detailed discussion of the rationale for chemigation safety devices, definitions of components of backflow prevention systems and interlock devices, the illustrations of the arrangement of components into functional safety systems, discussion of additional safety precautions and maintenance guidelines.

The EPA also sponsors a Chemigation Safety Committee, headed by Dr. Tom Ellwanger, that periodically reviews through correspondence and telephone communication items to be upgraded and PR notices and compliance statements to be issued by EPA. This Committee consists primarily of engineers and individuals involved in developing and manufacturing safety equipment.

Breakout Groups

Two breakout groups were formed and asked to address the eight topics (A-H) listed below. The following is a summary of the statements issued by the two groups.

Summary

(* = Cited by both groups)

A. What and where should Herbigation research be conducted?

1. All crops - alfalfa, peanuts, dry beans, cotton, corn should be emphasized.
2. Areas where groundwater and surface water contamination can occur.
3. Country-wide. Very well suited to all sprinkler irrigation systems.
4. Herbigation is plausible for all irrigation systems except furrow or flood types.

B. Why should Herbigation research be conducted?

1. Reduce nonpoint pollution. Nonpoint pollution has not received enough attention, especially for surface runoff.
2. Economical. The economics are especially favorable for actual cost of application.
3. Best application method available in many situations, especially in those situations where adverse weather conditions prevent field entry.
4. Requires less labor.
5. Improved timeliness both from the weather and crop growth point of view.

C. Advantages of Herbigation.

1. Economical.*
2. Reduces operator exposure.
3. Results in timely applications.*
4. Effective.
5. Reduces soil compaction.*
6. Has potential to reduce herbicide rates.*
7. Prescription applications, both vertically and horizontally.
8. Accommodates closed systems.
9. Has the potential for reduction of atmospheric transport. This has not been proven, but can be suggested because of its high carrier volume.
10. Environmental safety. Potential to use less herbicide may reduce potential pollution.
11. Better performance in no-till or conservation tillage. Better opportunity to get the chemicals through crop residue on the soil surface.
12. May be the only option available for entry in field under adverse weather conditions, as well as when potential interference by crop growth stage occurs.
13. Immediate activation and incorporation of herbicide.

D. Disadvantages or constraints of Herbigation.

1. Increased initial capital investment.
2. Uncertainty of herbicide registration. Chemical companies must support registration activities. There is a great deal of uncertainty regarding registration and reregistration.
3. Requires increased management. Technology is not for everyone.
4. May be impacted by water cost in some areas. Avail ability of water of adequate quantity and quality may affect Herbigation.
5. Lack of formulations for Herbigation, particularly for foliage-applied herbicides at the present time.
6. Higher rates of certain volatile herbicides such as trifluralin and EPTC may be required.
7. Cannot easily treat crops in field corners. Still need ground equipment for field corners.

8. Labels are not available in all areas of the country.

9. Postemergence efficacy of herbicides may be less. This depends on the system, gallonage applied per acre, and perhaps herbicide formulation.

10. Adverse public opinion. Their misconception and lack of acceptance are strong, specifically in relation to groundwater contamination.

11. Constraint of EPA policy or lack thereof is difficult to assess.

12. Technology transfer is lacking.

13. Lack of research effort compared to other application technology systems. Scientific years allocated to Herbigation is very limited.

14. Lack of research funding.

15. There is extremely low industry priority at the present time.

16. There is a great deal of competition by traditional application technologies. Other application technologies want to limit chemigation research.

E. What systems should be considered in Herbigation?

1. All types of sprinkler systems. Continuously moving systems are ideal. Solid set systems may not be as uniform and may not have fewer versatile applications.*

2. Drip/trickle systems should receive more emphasis.

3. Surface systems (flood, furrow, basin) should receive little if any consideration.

F. Comparison of soil vs. foliar applications of Herbigation.

1. Historically, soil-applied herbicides are the primary use.

2. System design and other factors such as formulation can make foliar applications work. Much more research is needed. A good example of foliar application of herbicides is buctril. Buctril has been effectively applied through irrigation on both corn and grain sorghum.

G. Research needed.

1. Potential for drift comparisons with other applications should be determined on a regional basis with ARS and University involvement.

2. Water quality effects. Potential for reduced leaching should be studied on a regional basis by ARS and University personnel.

3. Develop formulations for increased foliar activity with direct chemical industry involvement.

4. More application technology for Herbigation involving sprinklers, nozzles, water rates, safety factors, sensors and other aspects of application technology.

5. Herbicide residues in crops and other registration data need to be obtained by ARS, universities, and chemical companies. This could also involve IR-4 registrations as a bridge from other application technologies.

6. Coordination of application systems with multidisciplinary approaches.

7. Physiological studies involving uptake and retention of postemergence materials.

8. Additives including oils, adjuvants, and water volume application.

H. Who and where should research be conducted?

1. In the Central Plains on cotton, corn, and grain sorghum.

2. In the Northwest on potatoes.

3. In the Southeast on both agronomic and horticultural crops.

4. Do research where there is a high potential for new sprinkler irrigation systems.

5. Research should be conducted by State and Federal personnel where there is interest and facilities are available.

Dr. Joe Antognini developed a list of factors to be considered in comparing Herbigation vs. conventional spraying. The group was asked to respond to these factors in a survey. Clyde Dowler compiled the response from 17 individuals and recorded the following.

Herbigation vs. Ground Spraying Survey

Factor	Advantage		
	Yes	No	Yes/No*
Reduce herbicide rate/application	5	1	11
Reduce total amount of herbicide/A/season	5	1	11
Reduce number of herbicide applications	3	4	10
Registration costs		10	7
Reduced movement to groundwater	8	2	7
Reduced surface runoff	10	1	6
Reduced applicator exposure	17		
Reduced drift	9	4	4
Reduced soil compaction	16	1	
Use of postemergence herbicides	3	3	11
Use of preemergence herbicides	12	2	3
Formulations required	4	6	7
Adaptable to all irrigation practices/methods	2	13	2
Adaptable to all soil types	9	3	5
Adaptable to no-till-heavy crop residue	14		3
Reduced hazard to the public	11	1	5
Adaptable to weed sensing	2	7	8
Reduced potential for point source contamination	6	6	5
Reduced container disposal	5	5	7
Width of application window	15	1	1
Susceptibility of weeds/stage of growth	6	3	8
Use of herbicide mixtures	6	3	8
Simultaneous application of herbicides	7	3	7
Degree of management required	2	10	5
TOTALS	**182**	**90**	**141**

* Could be either depending upon the situation, herbicide, etc.

Herbigation Workshop Closing Remarks

Joe Antognini

1. Herbigation versus Chemigation:

In my introductory remarks, I mentioned we should confine our remarks and discussions to Herbigation and not cover all of chemigation. Since chemigation has crept into our discussions and breakout reports, I want to emphasize that there is a different set of criteria for Herbigation versus chemigation of fungicides, insecticides, miticides, and fertilizers. The most obvious difference is that fertilizers are not regulated by EPA-FIFRA. In the majority of cases, insecticides, miticides, and fungicides require thorough coverage of all crop leaf surfaces which is different than uniform coverage on the soil under a crop or to the small weeds under a crop canopy.

2. History:

One needs to look at the history of Herbigation and why it became popular in the 1960's and 1970's.

A. Little or no environmental (particularly ground and surface water) concerns.

B. There were unsolved weed problems - i.e. grass control in established alfalfa stands.

C. Little or no registration requirements if the product was already registered on the crop by "standard" application methods.

D. The industry and the Extension Service were behind it with data, demonstrations, meetings, literature, etc.

3. Where Are We Today:

A. Texas and Georgia - high interest with considerable recent research data.

B. West and Pacific Northwest - these two areas know how to use Herbigation but they have no recent data on it.

C. There is a general lack of interest across the country as a whole by research, Extension, and the grower community.

D. We know how to use Herbigation for consistent excellent results with soil-active compounds on full-till soil situations.

E. We do not know how to use Herbigation with consistent results with soil-active materials in no-till situations and with herbicides that are foliar active.

F. We need research on simultaneous applications of herbicides and other pesticides, on postemergence herbicides, and on adjuvants (stickers/spreaders/etc.).

4. Areas of Promise for Herbigation:

A. The only way to control a serious weed problem in a crop.

B. Reduce the volume of water per acre to the range of that for present "standard" applications.

C. LEPA system - low volume, drop nozzles, special nozzles, directed nozzles, etc., etc..

D. Where there is no chance of Herbigation water runoff, drift or movement through cracks and gopher holes, etc.

E. Obtain SLN-24-C labels where possible.

F. Where Herbigation is a routine practice, not a practice that is followed only when it doesn't rain enough.

5. Potential for Herbigation:

It appears to me that Herbigation has a limited use potential for the following reasons:

A. Registration problems - EPA guidelines are lacking but certainly considerable data beyond that required for "standard" spray applications will be required.

B. Research and grower interests are limited primarily to the Pacific Northwest (Columbia Basin), West Texas, and the Southeast (Georgia).

C. Herbicide manufacturers have a very limited interest because of registration costs (including cost of doing their research), limited markets, and environmental concerns.

D. The difficulty of conducting the research compared to the research with "standard" spray application methods. This difficulty essentially rules out IR-4 obtaining data for Herbigation registrations.

E. The higher degree of management required than for "standard" spray applications.

F. Special formulations may be required for a limited market and herbicide companies are reluctant to research, develop and register the special formulations due to inventory and carryover problems. This means that if the product does not move in one area, they are unable to move it into another area where there is a need for the product.

6. Contacts with Herbicide Manufacturers:

It is important that anyone conducting or contemplating R&D on Herbigation contact the registration department of the manufacturer and not the local rep of the manufacturer of the herbicide(s) and ask the following questions:

A. If Presently Registered:

- Does the company plan to maintain the registration (Federal and/or State)?
- Will the company be willing to recommend rates of ai lower than with standard applications?
- Do the recommendations fit the desired use pattern?
- Will they expand the label to include simultaneous applications with other herbicides and other pesticides?
- Will they develop formulations specifically designed for Herbigation?

B. If Not Presently Registered:

- Do they plan to obtain an EUP?
- Do they plan to register the use by State as well as with the EPA?
- Do they plan to register simultaneous applications with other herbicides and pesticides?
- Will they develop formulations specifically designed for Herbigation?

7. Planning Herbigation R&D:

In addition to the items discussed above when planning Herbigation R&D, one must remember:

A. Conservation tillage and no-tillage are increasing and will continue to do so.

B. The shift is to postemergence (foliar-applied herbicide) and away from preplant-incorporated and preemergence (soil-active) herbicides. This shift is a result of environmental concerns, the desire to treat the problem and not the anticipated problem and the fact that preplant and preemergence applications are not compatible with heavy crop residues.

C. Weed sensors are being developed to turn postemergence sprayers on and off as they detect given weed species/populations.

D. Ultra low volume postemergence sprays in oil with resulting reduced rates of active ingredient are being developed.

Closing Remarks

Clyde C. Dowler

I hope this Workshop has been worthwhile to each of you. I know it has taken time and expenditure of funds, but I hope the discussions and information presented will be worthwhile to each of you in the future. I believe we have had a good interchange of information and ideas. As stated earlier, a report on this Workshop will be developed and some of you will be asked for additional inputs. I hope you've enjoyed your stay in Tifton, and we look forward to more interchange of ideas in the future. If there are no additional comments or discussion, let's consider this Workshop adjourned.

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Appendix A

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PR NOTICE 87-1

NOTICE TO MANUFACTURERS, FORMULATORS, PRODUCERS AND REGISTRANTS OF PESTICIDE PRODUCTS

Attention: Persons Responsible for Registration of Pesticide Products

Subject: LABEL IMPROVEMENT PROGRAM FOR PESTICIDES APPLIED THROUGH IRRIGATION SYSTEMS (CHEMIGATION)

This Notice requires registrants of pesticide products registered under FIFRA and applied through irrigation systems to revise the labeling for such products to include additional use directions and other statements described in this Notice.

No end-use pesticide products labeled for agricultural, nursery, turf farm, golf course or greenhouse uses may be released for shipment by a registrant or producer of that product after April 30, 1988 unless the product bears an amended label which complies with the LIP.

I. THE LABEL IMPROVEMENT PROGRAM

On June 5, 1980, the Agency announced the establishment of a Label Improvement Program under which labels of products were to be upgraded, improved, or revised to meet current labeling standards. Notice of this progam was issued in the Federal Register and provided to all registrants as PR Notice 80-1. This Notice is issued under that LIP.

Pesticide labels are required to contain directions for use which are necessary for effecting the purpose for which the product is intended and are adequate to protect health and the environment. The label revisions required by this Notice, if adhered to by the users, will decrease environmental risks of pesticide contamination of ground water and will decrease direct human exposure to pesticide-treated irrigation water by providing appropriate use directions and restrictions or prohibitions. Although the Agency has received indirectly only very limited accounts of water source contamination or personal injury resulting from pesticide application through irrigation systems (chemigation), there is potential for such situations due to the increasing popularity of this application method, lack of public awareness that pesticides may be contained in irrigation water, lack of broad-based

or uniform regulation by individual states, and the absence of directions for use on pesticide labels. This last factor is due in part to the recent development of this application technology and equipment, and in part to FIFRA sec.2 (ee)(3) which allows "any method of application not prohibited by the labeling".

The Agency has received accounts of members of the general public intentionally using irrigation water in a variety of ways which could result in direct human exposure to pesticides if the system was being used for chemigation. The required label revisions, particularly those requiring posting to inform persons that irrigation water may contain pesticides, will decrease the likelihood of direct human exposure.

The required labeling will benefit users by providing them use directions for this relatively new method of application or will indicate that certain pesticides or application equipment should not be used and do not have the support of the registrant. In addition there will be uniform label requirements at the Federal level to address environmental concerns for this method of pesticide application. The Agency will also enhance its ability to enforce the requirements under the misuse provisions of FIFRA sec.12(a)(2)(G) which will encourage compliance by users.

The Agency believes that some of this safety equipment is already in use on more recently installed irrigation systems. Several states have regulations in place requiring similar equipment. There will be an economic impact on users who may have to install additional safety equipment. However, incremental costs of any additional equipment are small compared with the overall costs of the complete irrigation system itself. Another type of cost may be felt by users in the loss of availability of certain pesticides for chemigation because registrants elect to prohibit use rather than add use directions. Costs to registrants will be the cost of revising labels for those who must add the label prohibition or elect to add use directions for chemigation.

In all cases, the Agency believes that incremental costs will be outweighed by the benefits of having comprehensive and appropriate label use directions, of affording greater protection of the environment including ground water, and of greater enforcement capability to ensure compliance.

II. PESTICIDE PRODUCTS TO WHICH THIS NOTICE APPLIES

A. The requirements of this Notice apply to any pesticide product which:

1. May legally be applied through any type of irrigation system including any sprinkler, flood, furrow, drip or greenhouse system (pesticide products whose labels are silent on chemigation, i.e., neither recommend nor prohibit this application method, do legally allow this use); and

2. Is labeled for agricultural uses, nursery uses, turf farm uses, golf course uses or greenhouse uses; and

3. Is subject to FIFRA sec. 3 Registration, sec. 5 Experimental Use Permit, sec. 18 Emergency Use, or sec. 24(c) Special Local Need regulation.

B. The requirements of this Notice do not apply to any pesticide product which:

1. Is intended solely for residential use (such as indoor, yard or garden);

2. Is intended solely for direct injection into plants;

3. Is intended solely for post harvest application to produce; or

4. Is intended to be applied only as a gas or only as a solid, such as a pellet, tablet, granule or dust formulation.

C. This notice is not intended to limit chemigation practices to the types of irrigation systems given as examples above to the detriment of developing new technologies, nor is it intended to limit the Agency's concerns to those types of systems named as examples. If chemigation through other types of systems is intended, registrants must submit a detailed description of the system with proposed labeling for Agency review.

D. It is the Agency's intention to maintain as much flexibility as practicable in administering this LIP relative to FIFRA sec. 24(c) registrations. A label prohibition against chemigation of a product under FIFRA sec. 3 will not prohibit states from issuing a sec. 24 (c) registration for chemigation of that same product as long as labeling according to this LIP is incorporated into the sec. 24(c) registration.

III. IF CHEMIGATION IS NOT INTENDED

If it is your intention that your product not be applied through any type of chemigation system, add to your label the following prohibition statement: "Do not apply this product through any type of irrigation system." Skip to Section XI. of this Notice.

If at any time in the future you wish to replace the prohibition statement with the prescribed use directions and precautions in Sections IV. through IX., you must submit an application for amended registration to the appropriate Product Manager in the Registration Division. Applications for amended registration are not subject to the requirements of FIFRA sec. 3(c)(1)(D) pertaining to data compensation procedures.

IV. GENERIC LABEL STATEMENTS REQUIRED FOR CHEMIGATED PRODUCTS

If you intend that your product be applied by any type of chemigation system, all the following generic statements must be included on your label together with the specific requirements from one or more of Sections V. through IX.

A. "Apply this product only through [choose one or more of the following types of systems: sprinkler including center pivot, lateral move, end tow, side (wheel) roll, traveler, big gun, solid set, or hand move; flood (basin); furrow; border; or drip (trickle)] irrigation system(s). Do not apply this product through any other type of irrigation system."

B. "Crop injury, lack of effectiveness, or illegal pesticide residues in the crop can result from nonuniform distribution of treated water."

C. "If you have questions about calibration, you should contact State Extension Service specialists, equipment manufacturers or other experts."

D. "Do not connect an irrigation system (including greenhouse systems) used for pesticide application to a public water system unless the pesticide label-prescribed safety devices for public water systems are in place."

E. "A person knowledgeable of the chemigation system and responsible for its operation or under the supervision of the responsible person, shall shut the system down and make necessary adjustments should the need arise."

V. LABEL STATEMENTS FOR CHEMIGATED TOXICITY CATEGORY I PRODUCTS

In addition to generic label statements in Section IV., and specific label statements in one or more of Sections VI., VII., VIII., or IX., the labels of Toxicity Category I products (those with the label signal word DANGER) which allow chemigation must include the statements:

"Posting of areas to be chemigated is required when 1) any part of a treated area is within 300 feet of sensitive areas such as residential areas, labor camps, businesses, day care centers, hospitals, in-patient clinics, nursing homes or any public areas such as schools, parks, playgrounds, or other public facilities not including public roads, or 2) when the chemigated area is open to the public such as golf courses or retail greenhouses."

"Posting must conform to the following requirements. Treated areas shall be posted with signs at all usual points of entry and along likely routes of approach from the listed sensitive areas. When there are no usual points of entry, signs must be posted in the corners of the treated areas and in any other location affording maximum visibility to sensitive areas. The printed side of the sign should face away from the treated area towards the sensitive area. The signs shall be printed in English. Signs must be posted prior to application and must remain posted until foliage has dried and soil surface water has disappeared. Signs may remain in place indefinitely as long as they are composed of materials to prevent deterioration and maintain legibility for the duration of the posting period."

"All words shall consist of letters at least 2 1/2 inches tall, and all letters and the symbol shall be a color which sharply contrasts with their immediate background. At the top of the sign shall be the words KEEP OUT, followed by an octagonal stop sign symbol at least 8 inches in diameter containing the word STOP. Below the symbol shall be the words PESTICIDES IN IRRIGATION WATER." A small-scale illustration of an acceptable sign is attached at the end of this Notice.

Posting required for chemigation does not replace other posting and reentry interval requirements for farmworker safety.

VI. LABEL STATEMENTS FOR CHEMIGATION SYSTEMS CONNECTED TO PUBLIC WATER SYSTEMS

In addition to generic label statements in Section IV., and specific label statements in one or more of Sections VII., VIII. or IX., the labels of pesticide products which allow chemigation through systems connected to public water systems must include the statements:

A. Specific Required Label Statements

The following statements must be used verbatim:

1. "Public water system means a system for the provision to the public of piped water for human consumption if such system has at least 15 service connections or regularly serves an average of at least 25 individuals daily at least 60 days out of the year."

2. "Chemigation systems connected to public water systems must contain a functional, reduced-pressure zone, backflow preventer (RPZ) or the functional equivalent in the water supply line upstream from the point of pesticide introduction. As an option to the PRZ, the water from the public water system should be discharged into a reservoir tank prior to pesticide introduction. There shall be a complete physical break (air gap) between the outlet end of the fill pipe and the top or overflow rim of the reservoir tank of at least twice the inside diameter of the fill pipe."

3. "The pesticide injection pipeline must contain a functional, automatic, quick-closing check valve to prevent the flow of fluid back toward the injection pump."

4. "The pesticide injection pipeline must contain a functional, normally closed, solenoid-operated valve located on the intake side of the injection pump and connected to the system interlock to prevent fluid from being withdrawn from the supply tank when the irrigation system is either automatically or manually shut down."

5. "The system must contain functional interlocking controls to automatically shut off the pesticide injection pump when the water pump motor stops, or in cases where there is no water pump, when the water pressure decreases to the point where pesticide distribution is adversely affected."

6. "Systems must use a metering pump, such as a positive displacement injection pump (e.g., diaphragm pump) effectively designed and constructed of materials that are compatible with pesticides and capable of being fitted with a system interlock."

7. "Do not apply when wind speed favors drift beyond the area intended for treatment."

B. Nonspecific Required Label Statements

The following subjects must be addressed using the registrant's own wording:

1. Indicate whether agitation is or is not recommended in the pesticide supply tank. If it is not always recommended, identify the situations when it is recommended (e.g., when tank mixing with other pesticides or fluid fertilizers).

2. Indicate if the pesticide is to be applied continuously for the duration of the water application. If not, indicate when during the water application the pesticide is to be applied.

3. Provide mixing instructions for dilution of the pesticide in the supply tank.

C. Optional Label Statements

The following subject is not required, but may be addressed at the registrant's choosing:

1. Indicate the quantity of water to be applied per acre to achieve efficacy, but not cause runoff or excessive leaching. A range of quantities may be appropriate.

VII. LABEL STATEMENTS FOR SPRINKLER CHEMIGATION

A. Specific Required Label Statements

The following statements must be used verbatim:

1. "The system must contain a functional check valve, vacuum relief valve, and low pressure drain appropriately located on the irrigation pipeline to prevent water source contamination from backflow."

2. "The pesticide injection pipeline must contain a functional, automatic, quick-closing check valve to prevent the flow of fluid back toward the injection pump."

3. "The pesticide injection pipeline must also contain a functional, normally closed, solenoid-operated valve located on the intake side of the injection pump and connected to the system interlock to prevent fluid from being withdrawn from the supply tank when the irrigation system is either automatically or manually shut down."

4. "The system must contain functional interlocking controls to automatically shut off the pesticide injection pump when the water pump motor stops."

5. "The irrigation line or water pump must include a functional pressure switch which will stop the water pump motor when the water pressure decreases to the point where pesticide distribution is adversely affected."

6. "Systems must use a metering pump, such as a a positive displacement injection pump (e.g., diaphragm pump) effectively designed and constructed of materials that are compatible with pesticides and capable of being fitted with a system interlock."

7. " Do not apply when wind speed favors drift beyond the area intended for treatment."

B. Nonspecific Required Label Statements

The following subjects must be addressed using the registrant's own wording:

1. Indicate whether agitation is or is not recommended in the pesticide supply tank. If it is not always recommended, identify the situations when it is recommended (e.g., when tank mixing with other pesticides or fluid fertilizers).

2. Indicate if the pesticide is to be applied continuously for the duration of the water application. If not, indicate when during the water application the pesticide is to be applied.

3. Provide mixing instructions for dilution of the pesticide in the supply tank.

C. Optional Label Statements

The following subject is not required, but may be addressed at the registrant's choosing:

1. Indicate the quantity of water to be applied per acre to achieve efficacy, but not cause runoff or excessive leaching. A range of quantities may be appropriate.

VIII. LABEL STATEMENTS FOR FLOOD (BASIN), FURROW AND BORDER CHEMIGATION

A. Specific Required Label Statements

The following statements must be used verbatim:

Appendix A

1. "Systems using a gravity flow pesticide dispensing system must meter the pesticide into the water at the head of the field and downstream of a hydraulic discontinuity such as a drop structure or weir box to decrease potential for water source contamination from backflow if water flow stops."

2. "Systems utilizing a pressurized water and pesticide injection system must meet the following requirements:"

    a. "The system must contain a functional check valve, vacuum relief valve, and low pressure drain appropriately located on the irrigation pipeline to prevent water source contamination from backflow."

    b. "The pesticide injection pipeline must contain a functional, automatic, quick-closing check valve to prevent the flow of fluid back toward the injectio pump."

    c. "The pesticide injection pipeline must also contain a functional, normally closed, solenoid-operated valve located on the intake side of the injection pump and connected to the system interlock to prevent fluid from being withdrawn from the supply tank when the irrigation system is either automatically or manually shut down."

    d. "The system must contain functional interlocking controls to automatically shut off the pesticide injection pump when the water pump motor stops."

    e. "The irrigation line or water pump must include a functional pressure switch which will stop the water pump motor when the water pressure decreases to the point where pesticide distribution is adversely affected."

f. "Systems must use a metering pump, such as a positive displacement injection pump (e.g., diaphragm pump) effectively designed and constructed of materials that are compatible with pesticides and capable of being fitted with a system interlock."

B. Nonspecific Required Label Statements

The following subject must be adressed using the registrant's own wording:

1. Indicate whether or not a pesticide supply tank is recommended for the application. If it is recommended, provide mixing instructions for dilution of the pesticide in the tank. If agitation is not always recommended, identify the situations when it is recommended (e.g., when tank mixing with other pesticides or fluid fertilizers).

2. Indicate if the pesticide is to be applied continuously for the duration of the water application. If not, indicate when during the water application the pesticide is to be applied.

C. Optional Label Statements

The following subject is not required, but may be addressed at the registrant's choosing:

1. Indicate the quantity of water to be applied per acre to achieve efficacy, but not cause runoff or excessive leaching. A range of quantities may be appropriate.

Appendix A

IX. LABEL STATEMENTS FOR DRIP (TRICKLE) CHEMIGATION

A. Specific Required Label Statements

The following statements must be used verbatim:

1. "The system must contain a functional check valve, vacuum relief valve and low pressure drain appropriately located on the irrigation pipeline to prevent water source contamination from backflow."

2. "The pesticide injection pipeline must contain a functional, automatic, quick-closing check valve to prevent the flow of fluid back toward the injection pump."

3. "The pesticide injection pipeline must also contain a functional, normally closed, solenoid-operated valve located on the intake side of the injection pump and connected to the system interlock to prevent fluid from being withdrawn from the supply tank when the irrigation system is either automatically or manually shut down."

4. "The system must contain functional interlocking controls to automatically shut off the pesticide injection pump when the water pump motor stops."

5. "The irrigation line or water pump must include a functional pressure switch which will stop the water pump motor when the water pressure decreases to the point where pesticide distribution is adversely affected."

6. "Systems must use a metering pump such as a positive displacement injection pump (e.g., diaphragm pump) effectively designed and constructed of materials that are compatible with pesticides and capable of being fitted with a system interlock."

B. Nonspecific Required Label Statements

The following subjects must be addressed using the registrant's own wording:

1. Indicate whether or not a pesticide supply tank is recommended for the application. If it is recommended, provide mixing instructions for dilution of the pesticide in the tank and indicate whether agitation is or is not always recommended in the tank. If agitation is not always recommended, identify the situations when it is recommended (e.g., when tank mixing with other pesticides or fluid fertilizers).

2. Indicate if the pesticide is to be applied continuously for the duration of the water application. If not, indicate when during the water application the pesticide is to be applied.

C. Optional Label Statements

The following subject is not required, but may be addressed at the registrant's choosing:

1. Indicate the quantity of water to be applied per acre (or other measure of surface, volume etc.) to achieve efficacy, but not cause runoff or excessive leaching. A range of quantities may be appropriate.

X. FORMAT OF LABEL INFORMATION

If all information is included on the label itself, the label must meet the format requirements of 40 CFR 162.10. If chemigation label requirements are included in supplemental labeling rather than on the pesticide container label, the container label must contain the referral statement:

"CHEMIGATION:

Refer to supplemental labeling entitled (fill in title) for use directions for chemigation. Do not apply this product through any irrigation system unless the supplemental labeling on chemigation is followed."

Note that supplemental labeling accompanying the pesticide product or referred to on the container label is considered to be labeling under FIFRA and is subject to review and approval by the Agency.

XI. WHAT YOU MUST DO TO COMPLY

If you are the registrant of a pesticide product that is Federally registered under FIFRA sec 3:

A. First ascertain by examination of each product label whether or not each product is subject to this Notice according to the use patterns, sites, and formulations outlined in Section II. A. and B. above. For products not subject to this Notice no further action is required.

B. If you believe, for reasons other than those listed in Section II. A. and B. that your product should not be subject to the requirements of this Notice, you must submit a copy of the most current approved label and written justification supporting your position for Agency review by July 31, 1987. Claims for relative nontoxic status of a pesticide are not considered sufficient justification to warrant an exclusion from this LIP. Once this information has been submitted to the Agency through the appropriate Product Manager, you need not take any further action to comply with this Notice until a response is received from the Agency.

C. If your product is subject to this Notice you must take one of the following actions:

1. Revise your product labels in accordance with this Notice by either adding the prohibition statement in Section III. or the generic and specific label statements in Sections IV. through IX. No application for amended registration is required if the wording in Sections III. through IX. is used as given and information required to be provided by the registrant is included. If you choose this option, submit the following to the Agency:

   a. A letter indicating your intent to adopt the label language (either the prohibition or use directions) as specified in this Notice no later than July 31, 1987. A single letter may be submitted listing all affected products.

   b. A copy of the final printed labeling as revised; and a certification, signed by an authorized representative of your company, that the labeling as revised is in compliance with the requirements of this Notice no later than April 30, 1988.

2. If you wish to modify the required LIP statements in any substantive manner submit an application for amended registration, together with five copies of proposed labeling no later than July 31, 1987. Applications are not subject to the requirements of FIFRA sec. 3(c)(1)(D) pertaining to data compensation procedures. Applications must be submitted to the appropriate Product Manager at EPA for all Federally registered products.

If you are or will be the producer of a pesticide product subject to FIFRA sections 5, 18 or 24(c):

A. There is no need to amend currently approved labeling of products subject to FIFRA sec. 5 or 18.

B. The Agency will not, however, accept labeling submitted later than April 30, 1988 unless that labeling complies with the requirements of this LIP, i.e., either contains the prohibition or appropriate chemigation use directions.

C. Producers of pesticide products subject to FIFRA sec. 24(c) shall revise existing labels as per this LIP by April 30, 1988. Revised labeling and, if appropriate, a letter of certification shall be submitted to the state agency responsible for issuance or renewal of FIFRA sec. 24(c) registrations.

XII. COMPLIANCE DATES

All subject products released for shipment after April 30, 1988 must bear the revised labeling.

Products not in compliance as of this date will be deemed to be misbranded in violation of FIFRA sec. 12(a)(1)(E). The Agency may take enforcement action, issue Notices of Intent to Cancel the product's registration in accordance with FIFRA sec. 6, or both.

Registrants are reminded that:

A. A copy of the revised final printed label and, if appropriate, a certification statement must be submitted to the Agency prior to product distribution under that label. Revised labeling must be submitted by April 30, 1988.

B. It is the responsibility of the registrant to ensure that his distributors (sub-registrants) comply with these requirements within the time frames given.

XIII. FOR FURTHER INFORMATION

If you have questions regarding this Notice, or do not understand what you must do to comply, contact Dr. Thomas Ellwanger, Registration Division, Fungicide-Herbicide Branch at (703)557-1700.

If you have questions concerning the registration or amendment of a specific product, you must contact the Product Manager for that specific product.

Appendix A

The Agency address for correspondence and submission of applications is as follows:

Registration Division (TS-767C)
Environmental Protection Agency
401 M Street., S.W.
Washington, D.C. 20460

Edwin F. Tinsworth, Director
Registration Division

Appendix A

KEEP OUT

PESTICIDES IN IRRIGATION WATER

Appendix B

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

MAY 30 1991

OFFICE OF
PESTICIDES AND TOXIC
SUBSTANCES

MEMORANDUM

SUBJECT: Extension of the FIFRA Compliance Program Policy 12.7 on Chemigation

FROM: John J. Neylan III, Director
Policy and Grants Division
Office of Compliance Monitoring (EN-342)

TO: Addressees

The attached policy on chemigation and chemigation equipment went into effect on April 11, 1989. The cover memorandum to the policy stated that it would be in effect for one year while the Office of Pesticide Programs (OPP) reviewed the issue and decided whether or not to impose label changes. In the Spring of 1990, the policy was extended by one year.

Based on a memorandum from OPP which indicated that more time is needed, we have decided to extend the policy until further notice. The policy will remain in effect until OPP has completed its decision making and such decisions are implemented.

If you have any questions, please contact Virginia Lathrop at FTS 398-8292.

Attachment

Appendix B

ADDRESSEES

Douglas D. Campt	(TS-766C)
Allan S. Abramson	(TS-767C)
Anne E. Lindsay	(TS-767C)
Mike Walker	(LE-134A)
Mark Greenwood	(LE-132A)
Mike Stahl	"
Connie Musgrove	"
John J. Neylan III	"
David Dull	"
Mike Wood	"
Phyllis Flaherty	"
Jerry Stubbs	"
Maureen Lydon	"
Ken Kanagalingam	"
Bob Zisa	"
Jan Bearden	"
Linda Flick	"

Jake Mackenzie
Western Regional Compliance Director

I	Linda Murphy, Acting Director Air, Pest. & Toxics Mangt. Div.	Marvin Rosenstein, Chief Pesticides & Toxic Substances Br
II	Barbara Metzger, Director Environmental Services Division	Ernest Regna, Chief Pesticides & Toxic Substances Br
III	Thomas J. Maslany, Director Air, Tox. & Radiation Mangt. Div	James Burke, Chief Toxics & Pesticides Branch
IV	Winston A. Smith, Director Air, Pest. & Toxics Mangt. Div	James Kutzman, Chief Pesticides & Toxic Substances Br
V	William H. Sanders III, Director Environmental Services Division	Phyllis Reed, Chief Pesticides & Toxic Substances Br
VI	Stanley Meiburg, Acting Dir. Air, Pesticides & Toxic Division	Robert Murphy, Chief Pesticides & Toxic Substances Br
VII	William A. Spratlin, Director Air and Toxics Division	Leo Alderman, Chief Pesticides & Toxic Substances Br
VIII	Irwin L. Dickstein, Director Air and Toxics Division	C. Alvin Yorke, Chief Toxic Substances Branch
IX	David P. Howekamp, Director Air Management Division	Davis Bernstein, Chief Pesticides & Toxics Branch
X	Gary O'Neal, Director Air and Toxics Division	Kenneth Feigner, Chief Pesticides & Toxic Substances Br

cc:	Artie Williams	(H-7508C)
	John Tice	(TS-769C)
	OCM Staff	

Appendix B

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

APR 1 1 1989

OFFICE OF
PESTICIDES AND TOXIC SUBSTANCES

MEMORANDUM

SUBJECT: Interim Final FIFRA Compliance Program Policy 12.7

FROM: John J. Neylan III, Director
Policy and Grants Division
Office of Compliance Monitoring

TO: Addressees

Attached is an Interim Final FIFRA Compliance Program Policy 12.7 (chemigation) for immediate use, as well as for your review and comment. Please forward a copy of this policy to each State with which EPA has a FIFRA cooperative enforcement agreement for State review and comment.

This policy addresses the enforcement of the label provisions which were required in PR Notice 87-1. The policy states that EPA will not take an enforcement action under FIFRA section 12(a)(2)(G) against a person for using chemigation equipment which is not specified on the label if it is specified on a current list of comparable systems issued by EPA's Office of Pesticide Programs (OPP). A Chemigation Committee established by OPP has the responsibility for preparing and updating the list of approved, comparable equipment.

The attached list is the first, preliminary identification of comparable systems prepared by OPP. Because this list is subject to updates and modifications, it has not been made a part of this policy. Rather, the policy refers to "a current list of comparable systems," and provides information on how to obtain the list.

This is an interim final policy which will be in effect for one year from the date of this policy. During that year, OPP will review the issue of chemigation equipment and will decide whether or not to impose label changes to address the issues. Depending on the conclusions of this review, this interim policy may be withdrawn, modified, or extended.

Please submit your comments on this policy to Jan Bearden of my staff, mail code EN-342, E-mail EPA 7201, within 30 days of the date of this memorandum.

Attachments

Appendix B

INTERIM FINAL FIFRA COMPLIANCE PROGRAM POLICY NO. 12.7

Enforcement of the Label Improvement Program for Pesticides Applied Through Irrigation Systems (Chemigation)

FIFRA Section: 12(a)(2)(G)

Issue:

The PR Notice 87-1, which deals with chemigation, requires labels to bear very specific directions as to what equipment may be used. The States and the regulated community have indicated that other comparable systems exist and have requested EPA to allow such systems to be used instead of what is specified on the label.

Policy:

EPA will not take an enforcement action under FIFRA section 12(a)(2)(G) against a person for using chemigation equipment which is not specified on the label if it is specified on a current list of comparable systems issued by EPA's Office of Pesticide Programs (OPP).

Discussion:

The PR Notice 87-1 was issued on March 11, 1987, under EPA's Label Improvement Program (LIP). PR Notice 87-1 required: 1) registrants of pesticide products which are applied through chemigation to revise their labels to include additional use directions and equipment for chemigation; and 2) labels released for shipment after April 30, 1988, to be amended to comply with this Notice.

EPA recognizes that other, comparable technologies exist for the application of pesticides through chemigation besides those listed on the label. Such technologies have been proposed to the Agency by grower groups, equipment manufacturers, and State regulators. To evaluate such technologies, OPP has organized a Chemigation Committee consisting primarily of agricultural engineers from various parts of the country. Based on the Committee's evaluations, a list of comparable equipment has been prepared and will be updated or modified, as appropriate.

Although current labels require very specific equipment to be used for chemigation and prohibit the use of any other type of irrigation system, EPA will allow the use of alternative technologies which are approved by OPP for this purpose and contained on an approved list at the time of application.

Please note that any applicable restrictions or requirements as identified on the list and all other label directions must be followed. To obtain a copy of a current list of comparable systems, contact the Chief of the Registration Support Branch, (RSB-H7505C), Registration Division, Office of Pesticide Programs, U.S. EPA, 401 M Street, S.W., Washington, D.C. 20460.

References: PR Notice 87-1
Letters from:
J. Downing, Ocean Spray Cranberries, Inc. to P. Flaherty, Chief, Policy and Analysis Branch, Office of Compliance Monitoring (OCM), 9/12/88;
J. Downing, Ocean Spray Cranberries, Inc. to R. Ferrarin, New Jersey Dept. of Environmental Protection, 9/14/88;
T. Ellwanger, Office of Pesticide Programs, to Chemigation Committee, 12/8/88;
T. Ellwanger, Office of Pesticide Programs, to P. Flaherty, Chief, Policy and Analysis Branch, OCM, 2/21/89.

Key Words:

Enforcement, Chemigation, PR Notice 87-1

John J. Neylan III
Director
Policy and Grants Division
Office of Compliance Monitoring
APR 11 1989

Date

Appendix B

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

MAR 22 1989

OFFICE OF
PESTICIDES AND TOXIC SUBSTANCES

MEMORANDUM

SUBJECT: List of Alternative Chemigation Safety Equipment

FROM: Anne E. Lindsay, Director
Registration Division (H7505C)
Office of Pesticide Programs

TO: Phyllis Flaherty, Acting Director
Policy and Grants Division (EN-342)
Office of Compliance Monitoring

Please find attached OPP's approved list of alternative chemigation safety equipment. These devices are offered as alternatives to certain required components of chemigation systems in PR Notice 87-1, the Chemigation Label Improvement Program. I am sure you are aware of the urgency to get this information into the hands of State and Federal regulators as soon as possible for the impending growing season. If we can be of assistance in the timely distribution, please let us know. There are several grower groups, equipment manufacturers, committee members, and other interested parties with whom we have been working, so we would appreciate several copies of the final document. I have been advised that there may be some further expansion of this list of alternatives upon further consideration of the Chemigation Committee.

Please contact Dr. Tom Ellwanger (557-1700) on the status of the mailout and if there are questions on the technical aspects of the project.

Attachment

Appendix B

List of Alternative Chemigation Safety Equipment

PR Notice 87-1, the Label Improvement Program for Chemigation, issued March 11, 1987 requires that the labeling of agricultural pesticides intended for application through irrigation systems must include the use of certain types of safety devices to protect ground water from pesticide contamination. As a result of comments and new information received subsequent to issuance, a list of alternative devices to those included in PR Notice 87-1 has been considered and approved for use. In some cases these alternative devices may be less expensive, more reliable, or more available than some of those devices originally required. Be advised that all of the devices originally included in PR Notice 87-1 are still acceptable and that the PR Notice 87-1 is, in its entirety, still in effect. Devices required in PR Notice 87-1 which have no listed alternatives are still required components of all chemigation systems. The original devices as required in PR Notice 87-1 and their corresponding alternatives are listed below:

Original Device

Functional normally closed, solenoid-operated valve located on the intake side of the injection pump.

Alternative Device 1

Functional spring-loaded check valve with a minimum of 10 psi cracking pressure. The valve must prevent irrigation water under operating pressure from entering the pesticide injection line and must prevent leakage from the pesticide supply tank on system shutdown. This valve must be constructed of pesticidally resistant materials. [Note: this single device can substitute for both the solenoid-operated valve and the functional, automatic, quick closing check valve in the pesticide injection line.]

Alternative Device 2

Functional normally closed hydraulically operated check valve. The control line must be connected to the main water line such that the valve opens only when the main water line is adequately pressurized. This valve must prevent leakage from the pesticide supply tank on system shutdown. The valve must be constructed of pesticidally resistant materials.

Appendix B

Alternative Device 3

Functional vacuum relief valve located in the pesticide injection line between the positive displacement pesticide injection pump and the check valve. This alternative is appropriate for only those chemigation systems using a positive displacement pesticide injection pump and is not for use with venturi injection systems. This valve must be elevated at least 12 inches above the highest fluid level in the pesticide supply tank and must be the highest point in the injection line. The valve must open at 6 inches water vacuum or less and must be spring loaded or otherwise constructed such that it does not leak on closing. It must prevent leakage from the pesticide supply tank on system shutdown. The valve must be constructed of pesticidally resistant materials.

Original Device

Functional main water line check valve and main water line low pressure drain.

Alternative Device 1

Gooseneck pipe loop located in the main water line immediately downstream of the irrigation water pump. The bottom side of the pipe at the loop apex must be at least 24 inches above the highest sprinkler or other type of water emitting device. The loop must contain either a vacuum relief or combination air and vacuum relief valve at the apex of the pipe loop. The pesticide injection port must be located downstream of the apex of the pipe loop and at least 6 inches below the bottom side of the pipe at the loop apex.

Original Device

Positive displacement pesticide injection pump.

Alternative Device 1

Venturi systems including those inserted directly into the main water line, those installed in a bypass system, and those bypass systems boosted with an auxiliary water pump. Booster or auxiliary water pumps must be connected with the system interlock such that they are automatically shut off when the main line irrigation pump stops, or in cases where there is no main line irrigation pump, when the water pressure decreases to the point where pesticide distribution is adversely affected. Venturies must be constructed of pesticidally resistant materials. The line from the pesticide supply tank to the venturi must contain a functional, automatic, quick closing check valve to prevent the flow of liquid back toward

the pesticide supply tank. This valve must be located immediately adjacent to the venturi pesticide inlet. This same supply line must also contain either a functional normally closed solenoid-operated valve connected to the system interlock or a functional normally closed hydraulically operated valve which opens only when the main water line is adequately pressurized. In bypass systems as an option to placing both valves in the line from the pesticide supply tank, the check valve may be installed in the bypass immediately upstream of the venturi water inlet and either the normally closed solenoid or hydraulically operated valve may be installed immediately downstream of the venturi water outlet.

Original Device

Vacuum relief valve.

Alternative Device 1

Combination air and vacuum relief valve.

Herbigation Workshop Attendees

Name	Address	Phone
Antognini, Joe	National Program Leader Weed Science USDA-ARS Rm. 237, Bldg. 005, BARC-WEST Beltsville, MD 20705	(301) 344-3470
Beasley, David B.	University of Georgia Coastal Plain Expt. Stn. P. O. Box 748 Tifton, GA 31793	(912) 386-3377
Boydston, Rick A.	USDA-ARS Irrigated Agriculture Res. and Extension Center P. O. Box 2953-A Prosser, WA 99350	(509) 786-3454
Chandler, Laurence D.	USDA-ARS-IBPMRL Coastal Plain Expt. Stn. P. O. Box 748 Tifton, GA 31793	(912) 387-2326
Dowler, Clyde C.	USDA-ARS Coastal Plain Expt. Stn. P. O. Box 748 Tifton, GA 31793	(912) 386-3352
Glaze, Norman C.	USDA-ARS Coastal Plain Expt. Stn. P. O. Box 748 Tifton, GA 31793	(912) 386-3908
Gross, Harry R., Jr.	USDA-ARS Coastal Plain Expt. Stn. P. O. Box 748 Tifton, GA 31793	(912) 387-2343

Herbigation Workshop Attendees

Name	Address	Phone
Hanks, James E.	USDA-ARS Application Technology Res. P. O. Box 350 Stoneville, MS 38776	(601) 686-5382
Heerman, Dale F.	USDA-ARS AERC-CSU Ft. Collins, CO 80523	(303) 491-8229
Hilton, James L.	USDA-ARS Russell Agric. Res. Center P. O. Box 5677, College Stn. Rd. Athens, GA 30613	(404) 546-3328
Lunsford, James N.	ICI Americas, Inc. P. O. Box 8127 Dothan, AL 36303	(205) 983-1477
Lyle, W. M.	Texas A&M University Agricultural Res. and Ext. Lubbock, TX 79409	(806) 746-6101
McIntyre, Robert C.	Canaan Industries, Inc. 1101 Headland Avenue P. O. Box 8097 Dothan, AL 36304	(205) 793-9112
Newton, Gary	Agri-Inject, Inc. 419 South Houston Yuma, CO 80759	(303) 848-5336
Odiott, Olga	Environ. Protection Agency 401 M. Street, S.W., H-7505C Washington, DC 20460	(703) 557-4405
Ortega, Lamar	Lindsay Mfg. Co. 104 Needlepine Drive Dothan, AL 36301	(205) 793-9662

Herbigation Workshop Attendees (cont.)

Name	Address	Phone
Poss, Robert L.	Russell Daniel Irrigation Co. P. O. Box 365 Tifton, GA 31794	(912) 382-5844
Rogers, Charlie E.	USDA-ARS-IBPMRL Coastal Plain Expt. Stn. P. O. Box 748 Tifton, GA 31793	(912) 387-2330
Schweizer, Edward E.	USDA-ARS-NPA Crops Research Laboratory 1701 Center Avenue Ft. Collins, CO 80526	(303) 482-7717
Sumner, Harold R.	USDA-ARS-IBPMRL Coastal Plain Expt. Stn. P. O. Box 748 Tifton, GA 31793	(912) 387-2347
Threadgill, E. Dale	Dept. of Bio. & Agr. Eng. Driftmier Engineering Center University of Georgia Athens, GA 30602	(404) 542-1653
Wauchope, R. Don	USDA-ARS Coastal Plain Expt. Stn. P. O. Box 748 Tifton, GA 31793	(912) 386-7892
Wesley, Richard A.	USDA-ARS P. O. Box 36 Stoneville, MS 38776	(601) 686-5454
Yoder, Ronald E.	USDA-ARS Route 2, Box 2953-A Prosser, WA 99350	(509) 786-3354

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